A STUDY OF THE MECHANICS OF A RIGID SYSTEM OF MASS PARTICLES

BY

EDWARD W. SUPPIGER

B.S., University of Illinois, 1928

M.S., University of Illinois, 1932

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN ENGINEERING IN THE GRADUATE SCHOOL OF THE UNIVERSITY OF ILLINOIS, 1942

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ACKNOWLEDGMENTS

The writer wishes to thank Professor F. B. Seely, head of the Department of Theoretical and Applied Mechanics, for suggesting this study and arranging for its completion, and Professor W. L. Schwalbe, of the same department, who directed this study, for his interest and advice.

A STUDY OF THE MECHANICS OF A RIGID SYSTEM OF MASS PARTICLES

The object of this study is to derive the general equations of motion for a rigid system of mass particles in terms of: (1) force, mass, and acceleration; and (2) kinetic energy. The literature pertaining to this subject is extensive. Much of this material, however, has been written by (and in the language of) the mathematician and the mathematical physicist and it is not in a form that can be readily applied by the engineer.

The general equations of motion in terms of force, mass, and acceleration are obtained by the use of moving axes of reference and the relative acceleration equation: $a_p = a_{po} + a_o$ where a_p, a_{po}, and a_o represent the absolute linear acceleration of P, the linear acceleration of P relative to O, and the absolute linear acceleration of O, respectively. The kinematics and the kinetics involved in this study are treated separately. Special cases of the general equations are given, and several illustrative problems of an engineering nature are worked out in detail, both for a single particle and for a rigid body.

The general equations of motion in terms of kinetic energy are obtained by the use of moving axes of reference and the relative velocity equation: $v_p = v_{po} + v_o$, where v_p, v_{po}, and v_o represent the absolute linear velocity of P, the linear velocity of P relative to O, and the absolute linear velocity of O, respectively. The kinematics and the kinetics are again treated separately, and the final results are derived by both vector and scalar methods. The same illustrative problems that were solved by the equations of force, mass, and acceleration (both for a single particle and for a rigid body) are also solved by the equations in terms of kinetic energy. A comparison of the two methods of solution is thus afforded.

The concepts used in this study are widely used in engineering. After an understanding of the meaning of all terms appearing in the general equations has been acquired, the solution of most problems in rigid body motion is usually quite

direct since by proper choice of the moving XYZ-axes many of the terms that appear in the general equations, in any case, may be suppressed.

VITA

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